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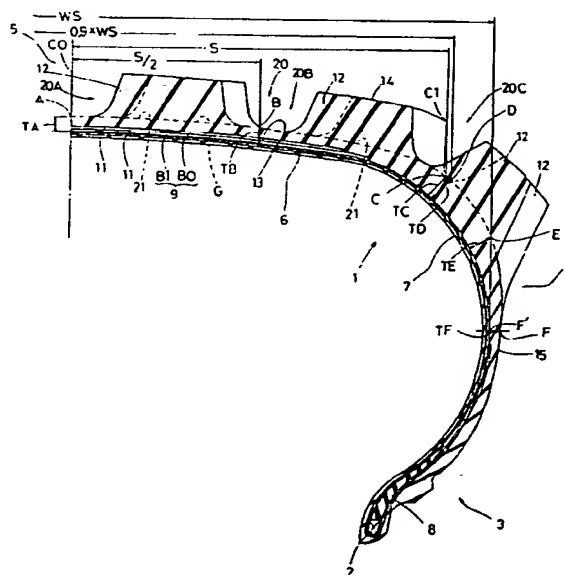
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(54) Off-road tyre.

(57) A belted cross ply tyre for off-the-road use comprising a tyre main body (1) and tread blocks (21) disposed around said tyre main body (1) to provide a block pattern, said tyre main body (1) comprising a pair of bead cores (2) disposed one in each of bead portions (3), a carcass (6) extending between the bead portions (3) and having two crossed plies turned up around the bead cores 2, a belt (9) disposed radially outside the carcass (6) and having two crossed plies (B1,B0) of parallel cords laid at an angle from 20 to 50 degrees to the tyre equator, a rubber layer disposed outside the carcass (6) and belt (9) to define a tread portion (5) and sidewall portions 4, characterised in that the rubber thickness of the tyre main body (1) is increased gradually from the tyre equator (CO) to the tyre shoulder portions and then gradually decreases to the maximum carcass cross sectional width points (F1) in the sidewall portions (4), wherein the said rubber thickness is defined as being measured from the outer profile (G) of the tyre main body (1) to the outer profile (13) of the carcass (6).

Fig. 1



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The present invention relates to a pneumatic tyre for off-the-road use, and more particularly to a tyre in which ride comfort, vibration damping, road grip, and steering stability are improved in a balanced manner.

In general, off-road tyres are inflated to a low internal pressure, for example 0.1 to 0.5 kg/sq.cm, when running off-the-road to increase the ground contacting area and also to absorb shocks.

5 However, due to such a low internal pressure and the resultant decreased tyre lateral stiffness, steering stability, vibration damping, ride comfort are liable to deterioration.

Heretofore, the performance of such tyres has been improved mainly by employing either a cross ply carcass with adjustment of the bias angles of the carcass cords, or a single ply radial carcass without a belt or by using a cordless carcass.

10 The properties of such prior art tyres were evaluated by a skilled test driver and are shown in Table 1 ranked from 1 to 5 in ascending order of improving performance.

As shown in Table 1, in a cross ply tyre, ride comfort and damping decrease if the carcass cord angles to the radial plane are small, whilst if the carcass cord angles are large, road grip and steering stability are liable to deteriorate.

15 Further, in a cordless-carcass tyre, although ride comfort is excellent, the other properties of the tyre are inferior.

Furthermore, in a beltless tyre with a single-radial- ply carcass, damping and steering stability are impaired.

Thus, it is very difficult to satisfy all the requirements for an off-the-road tyre.

20 It is therefore, an object of the present invention to provide an off-the-road tyre in which various tyre properties are improved in a well-balanced manner.

According to one aspect of the present invention an off-the-road tyre comprises a tyre main body and tread blocks disposed around said tyre main body to provide a block pattern, said tyre main body comprising a pair of bead cores disposed one in each of bead portions, a carcass extending between the bead portions and having two cross plies turned up around the bead cores, a belt disposed radially outside the carcass and having two cross plies of parallel cords laid at an angle from 20 to 50 degrees to the tyre equator, a rubber layer disposed outside the carcass and belt to define a tread portion and sidewall portions, characterised in that the rubber thickness of the tyre main body is gradually increased from the tyre equator to tyre shoulder portions and then gradually decreased to the maximum carcass cross sectional width points in the sidewall portions, wherein said rubber thickness is defined as measured from the outer profile (G) of the tyre main body to the outer profile (13) of the carcass.

30 Preferably the said rubber thickness has a distribution satisfying the following conditions:-
the quotient (TB/TA) of the thickness (TB) at a point (B) divided by the thickness (TA) at a point (A) is in the range from 1.25 to 1.65;
the quotient (TC/TB) of the thickness (TC) at a point (C) divided by the thickness (TB) at the above-mentioned points (B) is in the range from 1.2 to 2.0;
35 the quotient (TD/TC) of the thickness (TD) at a point (D) divided by the above-mentioned thickness (TC) is in the range from 1.0 to 1.2;
the quotient (TE/TC) of the thickness (TE) at a point (E) divided by the above-mentioned thickness (TC) is in the range from 1.0 to 1.5;
40 the quotient (TF/TE) of the thickness (TF) at a point (F) divided by the above-mentioned thickness (TE) is not less than 0.5 and less than 1.0.

Here, the above-mentioned rubber thickness is defined as measured from the outer profile (G) of the tyre main body to the outer profile (13) of the carcass; the above-mentioned points (A, B, C, D, E and F) are on the profile (g) of the tyre main body; the point (A) is positioned at the tyre equator (CO); the point (F) is at the same radial height as the maximum width point (F') of the carcass; the point (E) is at the same axial distance as the maximum width point (F') of the carcass, from the tyre equator (CO); the point (D) is at 90% of the above-mentioned axial distance of the maximum width point (F') of the carcass, from the tyre equator (CO); the point (C) is at the same axial distance (S) as the axial edges (C1) of the ground contacting area of the tread, from the tyre equator (CO), measured under a condition that the tyre is mounted on its scheduled rim and inflated to its scheduled pressure and loaded with its maximum tyre load; and the point (B) is at 50% of the above-mentioned axial distance (S), from the tyre equator (CO).

50 An embodiment of the present invention will now be described in detail in conjunction with the accompanying drawings, in which:

Fig.1 is a cross sectional view of an off-the-road tyre according to the present invention; and

55 Fig.2 is a partial plan view of the tyre showing the tread pattern thereof.

In the figures, a tyre of the invention is a bias ply tyre comprising a tread portion 5, a pair of axially spaced bead portions 3, and a pair of sidewall portions 4 extending from the bead portions 3 to the tread edges.

The tyre is formed by providing tread blocks 12 around a tyre main body 1.

The tyre main body 1 comprises a bead core 2 disposed in each of the bead portions 3, a carcass 6 extending between the bead portions 3, a belt 9 disposed on the radially outside of the carcass 6 in the tread portion 5, and a rubber layer disposed on the outsides of the carcass 6 and belt 9 so as to extend at least in to the tread portion 5 and sidewall portions 4.

5 The carcass 6 has a bias ply structure comprising a plurality of plies 7 (two crossed plies) of cords extending between the bead portions and turned up around the bead cores 2 from the axially inside to the outside thereof to form carcass turned up portions.

The turned up portions are terminated near the carcass maximum width point F' at which the cross sectional width of the carcass 6 is maximum when the tyre is mounted on its scheduled rim or officially approved rim for the tyre and inflated to its scheduled pressure and unloaded.

For the carcass cords, steel fibre cords or organic fibre cords, e.g. nylon, polyester of the like are used.

The cords in each of the carcass plies 7 are arranged at a bias angle in the range from 25 to 45 degrees with respect to a radial plane including the tyre axis.

15 If the angle is less than 25 degrees, ride comfort and vibration damping deteriorate. If the cord angle is more than 45 degrees, steering stability decreases.

Each of the bead portions 3 is provided with a bead apex 8. The bead apex 8 is disposed between the carcass main portion and each of the turned up portions, and extends radially outwardly from the bead core 2.

The belt 9 is composed of a radially inner belt ply BI disposed on the outer surface of the carcass 6 and a radially outer belt ply BO disposed thereon, each of which is made of high modulus organic fibre cords or steel fibre cords laid parallel to each other at an angle from 20 to 50 degrees with respect to the tyre equator CO.

The belt cords in one of the plies cross the belt cords in the other ply, thereby forming a stiff triangular truss structure in combination with the carcass cords.

If the belt cord angle is less than 20 degrees, ride comfort deteriorate. If the belt cord angle is more than 50 degrees, road grip and steering stability deteriorate.

25 On the outside of the assembly of the carcass, belt and the like, a rubber layer extending from one of the bead portions to the other bead portion is disposed to form the tyre main body 1.

Further, the tyre main body 1 is provided with a plurality of blocks 12 as mentioned above.

Thus the tread portion 5 of the tyre 1 is provided with a block pattern which comprises the above-mentioned blocks 12 divided by a plurality of circumferential grooves 20 and a plurality of axial grooves 21.

30 In this embodiment, five continuous circumferential grooves are provided; one central circumferential groove 20A at the tyre equator CO, two middle circumferential grooves 20B one on each side of the central groove 20A, and two shoulder circumferential grooves 20C in the tread shoulder regions.

The axial grooves 21 extend across the whole width of the tread portion and the axial ends thereof are opened at the tread edges towards the respective sidewall portions.

35 The block tread pattern has a sea/land ratio of more than 1. That is, the total grooved area is larger than the total block top area.

The tyre main body 1 has a profile G formed by a smoothly curved line devoid of any inflection point. In Fig.1, the profile G is shown by a broken line extending from the tyre equator to an upper sidewall point and then a solid line extending to the bead portion.

40 In practice the profile G is known from the groove base line.

In this invention, the thickness of rubber of the tyre main body 1, which is defined as measured from the profile G or outer face of the tyre main body 1 to the profile 13 or outer face of the carcass 6, has a specific distribution.

The thickness is gradually increased from the tyre equator CO to the tyre shoulder portions and then gradually decreased to the maximum carcass cross sectional width points.

45 At points A, B, C, D, E and F on the profile G, the respective thicknesses TA, TB, TC, TD, TE and TF are specifically defined as follows.

Here, the point A is positioned at the tyre equator CO; the point F is at the same radial height as the maximum width point F' of the carcass 6; the point E is at the same axial distance from the tyre equator CO as the maximum width point F' of the carcass 6, the point D is at 90% of the above-mentioned axial distance of the maximum width point F' of the carcass 6, from the tyre equator CO; the point C is at the same axial distance S from the tyre equator CO as the axial edges C1 of the ground contacting area of the tread, measured under the conditions that the tyre is mounted on its scheduled rim and inflated to its scheduled pressure and loaded with its maximum tyre load; and the point B is at 50% of the above-mentioned axial distance S from the tyre equator CO.

55 In the tread portion, the thickness is gradually increased from the equator point A to the edge point C through the middle point B.

The quotient TB/TA of the thickness TB at the middle point B divided by the thickness TA at the equator point A is in the range from 1.25 to 1.65.

The quotient TC/TB of the thickness TC at the edge point C divided by the thickness TB at the middle points B is in the range from 1.2 to 2.0.

If the thickness is increased abruptly beyond the above-mentioned ranges, steering stability is decreased. If the thickness is decreased gradually from the point A to the point C then to the contrary, ride comfort deteriorates.

Further, the quotient TD/TC of the thickness TD at the 90% width point D divided by the thickness TC at the edge point C is in the range from 1.0 to 1.2.

The quotient TE/TC of the thickness TE at the 100% width point E divided by the thickness TC at the edge point C is in the range from 1.0 to 1.5.

Thereby, the rigidity of the tread shoulder portion is optimised to improve the tyre performance.

Furthermore, the quotient TF/TE of the thickness TF at the maximum carcass width point F divided by the thickness TE at the 100% width point TE is not less than 0.5 and less than 1.0. Thereby, ride comfort and vibration damping are maintained or improved whilst a weight reduction in the tyre can be achieved.

Test tyres of size 110/90-18 were prepared and tested. The specifications of these and test results are given in Table 2.

In the tests, each tyre was mounted on its scheduled rim and inflated to its scheduled pressure of 2.25 kgf/sq.cm. Ride comfort, vibration damping, road grip and steering stability were evaluated into five ranks by a skilled test driver. Durability was evaluated from the distance the tyre ran before suffering damage.

In the five tests rankings of 4 and 5 are acceptable.

The durability is indicated by an index based on the reference tyre 1 being 100. The larger the value, then the better the durability.

From the test results, the working example tyres EX1-EX4 according to the present invention were found to be superior to the reference tyres REF1-REF3 because the ride comfort, vibration damping, road grip, steering stability, and durability were improved in a well-balanced manner.

TABLE 1

Tire	A	B	C	D
Carcass	two cross plies with large cord angle	two cross plies with small cord angle	cordless	one radial ply beltless
Ride comfort	4	2	5	5
Vibration damping	4	3	3	3
Road grip	4	5	3	4
Steering stability	3	5	2	2

TABLE 2

Tire	Ex. 1	Ex. 2	Ex. 3	Ex. 4	Ref. 1	Ref. 2	Ref. 3
Carcass							
Structure	Bias	Bias	Bias	Bias	Bias	Bias	Radial
Ply No.	2	2	2	2	2	2	1
Cord	2/1260d	2/1260d	2/1260d	2/1260d	2/1260d	2/1260d	2/1260d
Count	39	39	39	39	39	39	39
Cord angle (deg.)	25	45	35	35	50	20	90
Belt							
Cord	2/1260d	2/1260d	2/1260d	2/1260d	2/1260d	2/1260d	2/1260d
Count	39	39	39	39	39	39	39
Ply No.	2	2	2	2	2	2	2
Cord angle (deg.)	50	20	30	50	55	15	15
Bead apex Height (mm)	40	40	40	40	40	40	40
Rubber thickness							
TB/TA	1.25	1.65	1.5	1.3	1.2	1.7	1.0
TC/TB	1.2	2.0	1.8	1.5	1.0	2.2	1.16
TD/TC	1.0	1.2	1.2	1.2	0.8	1.3	1.56
TE/TC	1.0	1.5	1.3	1.2	0.8	1.8	0.75
TF/TE	0.5	1.0	1.0	0.8	0.3	1.2	1.0
Test result							
Ride comfort	4	4	4	4	3	2	5
Damping	4	4	4	4	3	3	3
Road grip	4	4	4	4	3	4	4
Steering stability	4	4	4	4	3	4	2
Durability	118	118	118	118	100	108	94

Claims

1. A belted cross ply tyre for off-the-road use comprising a tyre main body (1) and tread blocks (21) disposed around said tyre main body (1) to provide a block pattern, said tyre main body (1) comprising a pair of bead cores (2) disposed one in each of bead portions (3), a carcass (6) extending between the bead por-

tions (3) and having two crossed plies turned up around the bead cores 2, a belt (9) disposed radially outside the carcass (6) and having two crossed plies (B1,B0) of parallel cords laid at an angle from 20 to 50 degrees to the tyre equator, a rubber layer disposed outside the carcass (6) and belt (9) to define a tread portion (5) and sidewall portions 4, characterised in that the rubber thickness of the tyre main body (1) is increased gradually from the tyre equator (CO) to the tyre shoulder portions and then gradually decreases to the maximum carcass cross sectional width points (F1) in the sidewall portions (4), wherein the said rubber thickness is defined as being measured from the outer profile (G) of the tyre main body (1) to the outer profile (13) of the carcass (6).

2. A belted cross ply tyre according to claim 1, characterised by said rubber thickness having a distribution satisfying the following conditions:

the quotient (TB/TA) of the thickness (TB) at a point (B) divided by the thickness (TA) at said point (A) is in the range from 1.25 to 1.65;

the quotient (TC/TB) of the thickness (TC) at said point (C) divided by the thickness (TB) at said points (B) is in the range from 1.2 to 2.0;

the rubber thickness is gradually increased from the point (A) to the point (C);

the quotient (TD/TC) of the thickness (TD) at a point (D) divided by said thickness (TC) is in the range from 1.0 to 1.2;

the quotient (TE/TC) of the thickness (TE) at a point (E) divided by said thickness (TC) is in the range from 1.0 to 1.5;

the quotient (TF/TE) of the thickness (TF) at a point (F) divided by said thickness (TE) is not less than 0.5 and less than 1.0; and

the rubber thickness is gradually increased from the point (F) to the point (E); wherein said points (A, B, C, D, E and F) are on the profile (G) of the tyre main body;

the point (A) is positioned at the tyre equator (CO);

the point (F) is at the same radial height as the maximum width point (F') of the carcass;

the point (E) is at the same axial distance as the maximum width point (F') of the carcass, from the tyre equator (CO);

the point (D) is at 90% of said axial distance of the maximum width point (F') of the carcass, from the tyre equator (CO);

the point (C) is at the same axial distance (S) as the axial edges (C1) of the ground contacting area of the tread, from the tyre equator (CO), measured under a condition that the tyre is mounted on its scheduled rim and inflated to its scheduled pressure and loaded with its maximum tyre load; and

the point (B) is at 50% of said axial distance (S), from the tyre equator (CO).

3. A belted cross ply tyre according to claim 1 or 2, characterized in that the tread portion (5) is provided with a plurality of circumferentially extending grooves (20A,20B,20C) and a plurality of axially extending grooves (21) defining said blocks (12), and said axially extending grooves (21) extend across the whole width of the tread (5) and the axially outermost ends are opened at the tyre sidewalls (15).

4. A belted cross ply tyre according to claim 1, 2 or 3, characterised in that said block pattern has a sea/land ratio of more than 1.

Fig. 1

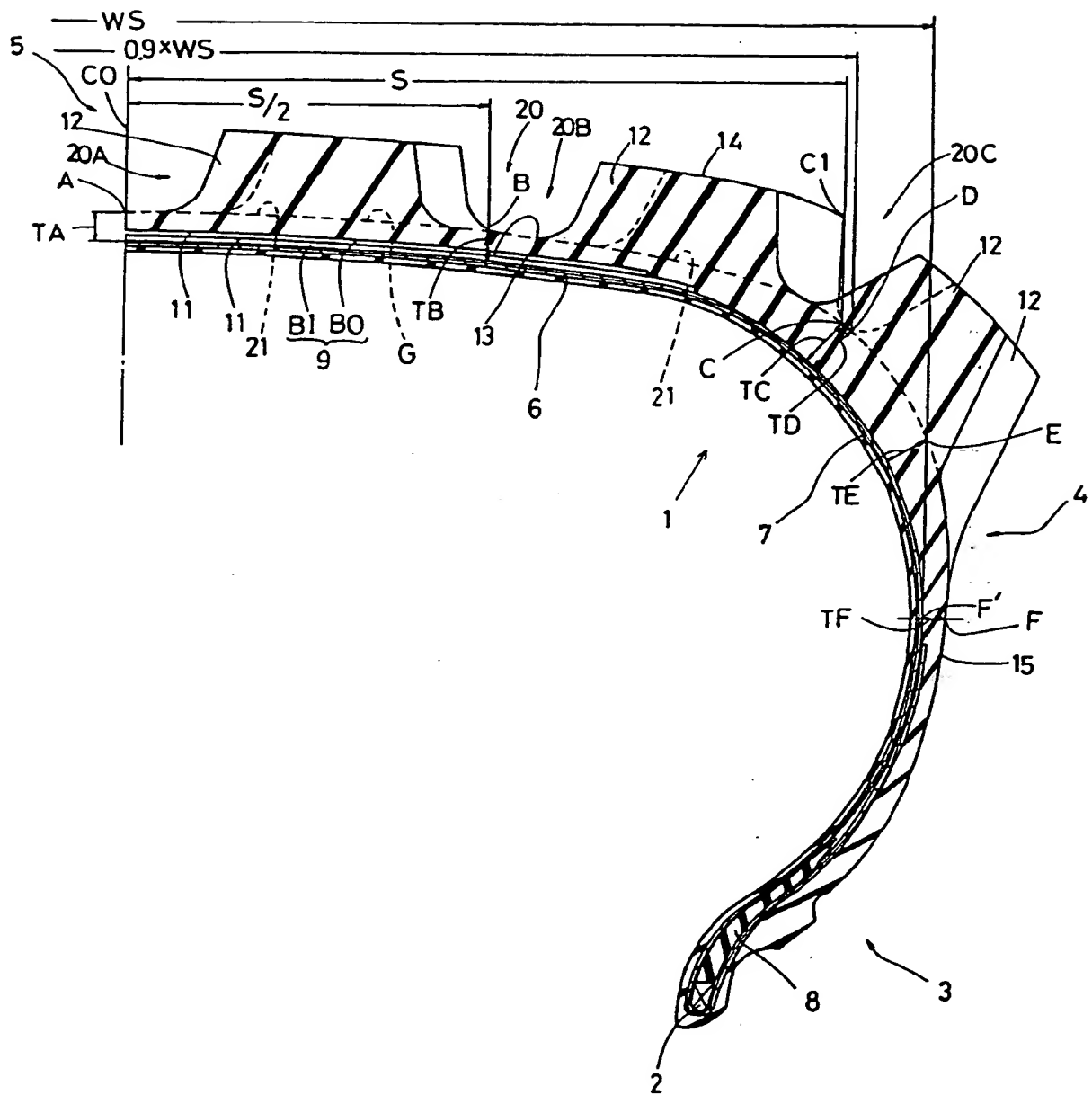
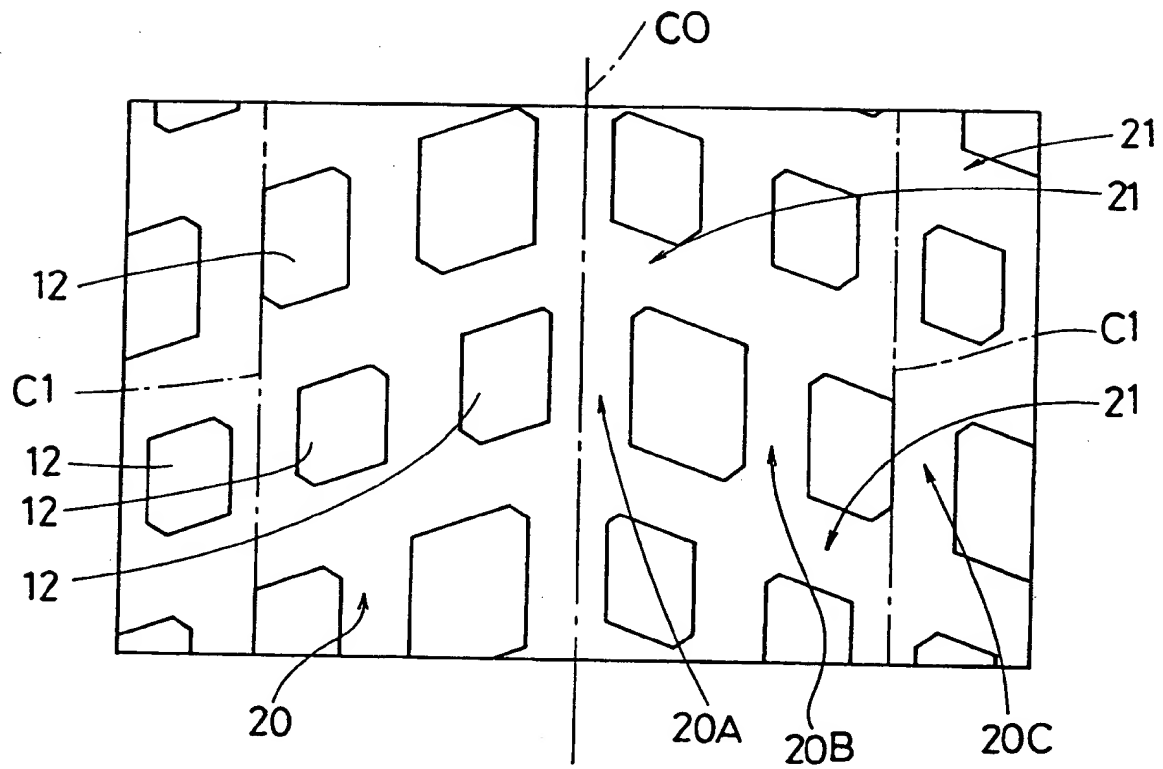


Fig. 2





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EUROPEAN SEARCH REPORT

Application Number

EP 92 30 3229

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
Y	US-A-4 955 417 (Y. IGARASHI) * column 1, line 1 - line 61; claims; figures; table 1 *	1	B60C11/00 B60C11/01
Y	--- PATENT ABSTRACTS OF JAPAN vol. 9, no. 297 (M-432)(2020) 25 November 1985 & JP-A-60 135 310 (SUMITOMO GOMU KOGYO K.K.) 18 July 1985 * abstract *	1	
A	--- EP-A-0 359 734 (SEMPERIT REIFEN AG) * page 3, column 3, line 7 - line 25; claim 1; figure 1 *	1-4	
A	--- US-A-4 617 976 (J. KAWAJIRI) * column 2, line 41 - line 47; claims; figure 1 *	3,4	
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			B60C
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 27 JULY 1992	Examiner BARADAT J. L.
<p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background : non-written disclosure P : intermediate document</p> <p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons</p> <p>_____ & : member of the same patent family, corresponding document</p>			

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